REMARKS

Applicant respectfully requests reconsideration of the present application in view of the foregoing amendments and in view of the reasons that follow.

No claims are currently being amended. A detailed listing of all claims that are, or were, in the application, irrespective of whether the claim(s) remain under examination in the application, is presented, with an appropriate defined status identifier. Claims 1, 3-12, 14-18 and 20-25 remain pending in this application.

Rejections under 35 U.S.C. § 103

Claims 1, 3-12, 14-18 and 20-23 stand rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,693,203 to Ohhashi et al. (hereafter "Ohhashi"). Claims 24-25 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Ohhashi in view of acknowledged prior art on page 2, lines 1-24 (hereafter "the APA"). Applicants respectfully traverse these rejections for at least the following reasons.

Claims 1 and 18

Claims 1 and 18 are directed to high purity Nb sputtering targets that respectively comprise an amount of Ta and oxygen, impurities that are inevitable impurities in Nb sputtering targets, but are controlled sufficiently in the sputtering targets as recited. The rejection based on Takahashi is premised on the finding that the oxygen and Ta content in the Takahashi Nb sputtering target could be eliminated and thus would be zero. Specifically, the Office Action alleges that the "recited O and Ta contents read on zero which suggests said elements could be eliminated from the sputtering targets." Applicants respectfully disagree.

Ta and oxygen are inevitable impurities in Nb sputtering targets, and thus cannot be readily eliminated therefrom. As described in the present specification on page 7, lines 16-22, since Nb and Ta are in an adjacent relationship in the periodic table (both are group 5A elements), Nb raw material necessarily contains Ta. Accordingly, it is difficult to completely separate Ta from Nb, and it is unavoidable that available Nb material for a sputtering target contains some amount of Ta. Similarly, oxygen inevitably exists as an impurity in some amount in a Nb sputtering target.

In sum, because Ta and oxygen are inevitable impurities in a Nb sputtering target, the contention in the Office Action that the oxygen and Ta content of the Takahashi Nb sputtering target could be eliminated is simply incorrect, and the rejection based on Takahashi which is based on this incorrect premise must fail.

Moreover, claims 1 and 18 require some amount of Ta and oxygen, respectively, and thus modifying the Takahashi Nb sputtering target to include zero Ta and oxygen would result in a sputtering target outside the scope of claims 1 and 18. Claim 1 is directed to a sputtering target consisting essentially of Nb comprising an amount of Ta, wherein the Ta content is 3000 ppm or less. Claim 18 is directed to a sputtering target consisting essentially of Nb comprising an amount of oxygen, wherein the oxygen content is 200 ppm or less. Thus, the sputtering targets of claims 1 and 18, comprising an amount of Ta, and an amount of oxygen, respectively, preclude zero Ta and zero oxygen content, respectively.

Ohhashi fails to suggest that the impurities of Ta and oxygen can be totally eliminated from a Nb sputtering target, or how this would be accomplished. This is entirely consistent with the notion that persons skilled in the art would not understand that the present claims can be read on a zero % content of either Ta or oxygen.

Moreover, claims 1 and 18 require a specific dispersion of Ta and oxygen in the sputtering target, which is not suggested in Takahashi. Claims 1 and 18 recite, respectively, that the dispersion of the Ta content in the target is within 30%, and that the dispersion of the oxygen content in the target is within 80%. The Office Action continues to suggest that a zero content of Ta or oxygen would result in a zero % content dispersion stating:

> The recited O and Ta contents read on zero which suggests said elements could be eliminated from the sputtering target. Then the maximum and minimum values of said elements is zero. Thus, the dispersion % of said O and Ta is zero.

Applicants again submit that the Office Action is not correct in suggesting that a zero content of Ta or oxygen (even if this were possible, which it is not) would result in a zero % content dispersion, because in the limit as the content approaches zero the dispersion would not be zero unless the ratio of the maximum and minimum values is equal to one. The

dispersion, as defined in claims 1 and 18, is given as: ((maximum value - minimum value) / (maximum value + minimum value)) x 100. Setting the maximum value and the minimum value to zero provides that the dispersion is (0/0)x100, which is indeterminate, not zero. From a mathematical point of view, the dispersion must be determined by taking the limit of the dispersion as the maximum value and the minimum value approach zero. In this case, the dispersion is zero only if the (maximum value/ minimum value) goes to one in the limit as the maximum value and the minimum value approach zero (which Takahashi does not and can not show). Thus, the rejection is based on an incorrect factual premise.

Moreover, the specific Ta and oxygen content in claims 1 and 18 provide solutions to problems recognized by the inventors of the present application, while Takahashi fails to recognize the content of Ta or oxygen as a result-effective variable, much less provide the solution as recited in claims 1 and 18.

One object of the invention is to provide a sputtering target that, when applied to dual damascene interconnection technology to form an Al interconnection film, enables improved electrical characteristics and quality of a Nb liner film for the Al film. In particular, the object is to provide a Nb sputtering target that enables one to obtain, with reproducibility, a Nb film capable of suppressing the increase in resistivity of an Al interconnection film to, for instance, $4\mu\,\Omega$ cm or less and the occurrence of dust (see present specification, page 3, line 22 to page 4, line 4).

As a result of intensive studies, the inventors have determined important parameters in solving the above problems. Namely, the inventors have found that in high purity Nb sputtering targets, the dispersion and content of Ta in the Nb target, the Nb average grain size and the grain size ratio of adjacent grains in the Nb target, and the dispersion and content of oxygen in the Nb target are important parameters. These parameters are implemented in the sputtering targets of independent claims 1, 10, and 18, which recite, respectively, the content and dispersion of Ta, grain size parameters, and the content and dispersion of oxygen which provide an improved Nb sputtering target.

Both the Ta content and Ta content dispersion as recited in claim 1 are important. The Ta content alone is not a sufficient parameter to control in the Nb sputtering target. For

example, although the Ta content of example 3 of Table 1 is only 1830 ppm, a relatively high resistivity results because of the poor dispersion of the Ta in that example.

Both the oxygen content and oxygen content dispersion as recited in claim 18 are important. The oxygen content alone is not a sufficient parameter to control. For example, although the oxygen content of example 1 of Table 3 is only 10 ppm, the resistivity of the interconnection formed using the sputtering target is 4.2 $\mu\Omega$ cm, which exceeds the target value of 4.0 $\mu\Omega$ cm due to the dispersion of oxygen content of 82% which exceeds 80%.

Ohhashi fails to teach or suggest controlling either the dispersion of oxygen content or the dispersion of Ta content for a Nb sputtering target. Specifically, Ohhashi fails to disclose or suggest controlling the dispersion of Ta content in a Nb sputtering target to be within 30% in contrast to claim 1, or the controlling the dispersion of oxygen content in a Nb sputtering target to be within 80% in contrast to claim 18. Therefore, it is clear on this record that the prior art is devoid of any teaching whatsoever of the specifically claimed parameters of claims 1 and 18. Thus, the rejection is improper and should be withdrawn.

Furthermore, the Office Action again (as in the prior Office Action) grounds its reasoning for obviousness in part on the principle that "optimization of a variable *recognized in the art as a result-effective variable* normally is considered to be within the ordinary skill in the art." Again, while Applicants do not quarrel with the statement of the general principle, they do point out that the present record is devoid of any evidence that those skilled in this art recognized that the claimed parameters were "result-effective" for the results sought after by the Applicants. Thus, this principle of law has no application to the present context. If the PTO continues to maintain this reasoning, Applicants respectfully request the PTO to point out where in the prior art the claimed parameters are recognized as "result effective."

Claim 10

Claim 10 recites parameters concerning the grain diameter size of a Nb target. Claim 10 recites an average grain diameter of 100μm or less and a grain diameter in the range of 0.1 to 10 times an average grain diameter. As shown in Table 5 and discussed on pages 28-29 of

the specification, a Nb target with the recited grain size parameters allows for suppressed occurrence of dust when sputtering.

Ohhashi fails to disclose a Nb target with an average grain diameter of 100μm or less, or its attendant advantages in reducing dust. Ohhashi discloses that the sputtering target should have a uniform microstructure and a crystal grain size of no more than 350 μm. Ohhashi, however, does not disclose an average grain diameter of 100μm or less or recognize that the Nb sputtering target should have such a grain size in order to reduce dust. Because the reference fails to recognize either the problem or the presently claimed solution for that problem, the reference cannot "teach" the present invention. As mentioned above, claim 10 also recites a grain diameter in the range of 0.1 to 10 times an average grain diameter, and additionally recites a grain size ratio of adjacent grains in the range of 0.1 to 10, parameters not disclosed by Ohhashi which suggests only a uniform microstructure. Accordingly, the rejection of claim 10 based on Ohhashi should be withdrawn as well.

The Office Action states that the instant grain size (presumably of claim 10) is up to 1500 μm (average grain size 150 μm x 10) which is overlapped by uniform grain sizes no more than 350 μm as taught by Ohhashi. This statement, aside from being incorrect, misses the point that Ohhashi does not suggest an average grain size less than 100 μm, or the advantages thereof in preventing dust. The above statement is incorrect at least in that the largest grain size contemplated in claim 10 would be 100 μm x 10, or 1000 μm, not 1500 μm. More importantly, however, it is the average grain size as recited that provides advantages in reducing dust. Whether or not some of the larger grains (grains up to 1000 μm) fall within the scope of the grains in the Ohhashi target is irrelevant. Neither does Ohhashi recognize that the average grain size is important in reducing dust, nor does Ohhashi disclose the specific average grain size recited in claim 10.

The APA also fails to suggest the parameters as recited in claims 1, 10 and 18, and thus fails to cure the deficiencies of Ohhashi.

For at least the reasons given above, applicants respectfully submit that claims 1, 10 and 18 are patentable over Ohhashi and the APA. Independent claims 24 and 25 include the same Ta and oxygen parameter limitations of claims 1 and 18, respectively, and are thus

patentable for at least the same reasons. The dependent claims depend from one of claims 1, 10, and 18, and are patentable for at least the same reasons, as well as for further patentable features recited therein.

Applicant believes that the present application is now in condition for allowance. Favorable reconsideration of the application as amended is respectfully requested.

The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application.

The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 19-0741. Should no proper payment be enclosed herewith, as by a check being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 19-0741. If any extensions of time are needed for timely acceptance of papers submitted herewith, Applicant hereby petitions for such extension under 37 C.F.R. §1.136 and authorizes payment of any such extensions fees to Deposit Account No. 19-0741.

Respectfully submitted,

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